DISINFECTANTS
GENERAL PROPERTIES

An ideal swimming pool and spa pool disinfectant would produce two extremely important distinct effects:

- a residual bactericidal effect; and
- an oxidation effect.

While some chemicals can do both, some chemicals can only disinfect or oxidize. Some chemicals may be bactericidal for a short time but rapidly dissipate to leave the pool without a residual protection. It is important to be able to measure the amount of disinfectant in the pool water or to be able to measure the disinfection power of the disinfectant. There is no ideal disinfectant as all disinfectants have their relative strengths and weaknesses. Before a disinfectant or disinfectant system is installed it is recommended that advice from a pool professional or consulting engineer be sought.

Some suitable disinfectants are:

Chlorine

The disinfectant form of chlorine is "free residual chlorine." It is also known as “free available chlorine” or “free chlorine” and all terms refer to the concentration of hypochlorous acid and the hypochlorite ion in equilibrium concentration in the pool water. It is strong and safe when used properly and is still the most popular form of disinfection. There is much material available on the techniques of chlorination and "breakpoint chlorination" in particular; and it is excellent practice to attain breakpoint before the first chlorine measurements are taken each day. Breakpoint chlorination means that all of the chlorine is available as free chlorine. This is achieved by adding sufficient chlorine to burn out all the combined chlorine, so that free chlorine equals total chlorine. See http://www.dhss.mo.gov/RecreationalWater/PoolsSpas.htm and hyperlink to the SWIMMING POOL WATER CHEMISTRY guide for detailed discussions.

The higher the pH above 7 the less the disinfection power of free chlorine. pH needs to be properly controlled in a swimming pool and spa pool when chlorine is used and automatic adjustment is recommended to levels between 7.2 and 7.8.

Free residual chlorine can also oxidize ammonia, some other organic compounds and some organic nitrogen introduced into the pool by urine or perspiration. Free chlorine however can combine with ammonia to form compounds, known as chloramines, which cause eye stinging and reduce the ability of chlorine to disinfect, particularly in indoor pools. Chloramines, also known as "combined residual chlorine", should be kept to a minimum. Adding more chlorine to oxidize them over a period of time without bathers in the pool does this.

Chlorine is available in many forms and not all forms are appropriate for all applications. Calcium hypochlorite (powdered or granular chlorine) for example should not be used in hot spas as it may promote scaling on heat exchangers and on hot water control valves, which may lead to scalding. Cyanurated chlorine (stabilized chlorine) should not be used in indoor pools. Bromine may be used as a trace disinfectant to reduce the adverse effects of chlorine.

Bromine

Bromine is a weaker disinfectant than its chlorine equivalent and to achieve similar disinfection bromine needs to be at concentrations of at least 50% to 60% higher than chlorine and this is recognized in the chemical criteria of these guidelines. Bromine reacts with nitrogenous compounds in a similar way to chlorine to produce bromines. They do not however, cause the serious bather discomfort, as do chloramines. There are fewer complaints of eye irritation and obnoxious chemical related odors when bromine is used as a disinfectant, which makes bromine more suited to indoor pools. The test method cannot differentiate between free and combined bromine. This is not so important because free bromine and combined bromine have a similar disinfection efficiency.

Bromine is less stable than chlorine when exposed to ultra violet light but unlike chlorine cannot be stabilized and is therefore less suitable for outdoor pools than chlorine. A stabilized chloro/bromide system may also be considered.

As pH increases disinfection power is lost. However, the loss of disinfection power is less than that experienced by chlorine over the swimming pool and spa pool pH range of 7.2 to 7.8.

There have been reported cases of skin rashes and sensitization to bromine systems where BCDMH (bromochlorodimethylhydantoin) was the disinfection agent. The sensitization occurs over a period of time at excessive levels to produce contact dermatitis symptoms and individual sensitization appears to be permanent. Further research is needed to assess this problem fully.

Salt Water Chlorination (Electrolysis)

Salt water chlorination is the process of electrolysis of salt water. The electrodes produce chlorine and hydrogen in gaseous form at a constant rate determined by the salinity of the pool water. It is important to maintain correct salinity levels or the chlorination production rate declines. While hydrogen may be liberated as a gas the chlorine rapidly dissolves to form "free chlorine" and follows the usual chlorine swimming pool chemistry, except that the chloride ion may reform and be available again for conversion in electrolysis.

Salt water chlorination does not have the ability to respond adequately to shock loadings and a backup continuous dosing system or a bank of electrolysis units should also be provided. Overnight and supplementary slug hand dosing with chlorine compounds may be required. Slug dosing should never be done within three hours before bathers are admitted to the swimming pool or spa pool or while people are bathing.

Isocyanurated Chlorine Compounds (Stabilizer)

Isocyanurated chlorine compounds and isocyanuric acid are used to stabilize chlorine against losses due to ultra violet light in direct sunlight. Chlorinated isocyanurates, when dissolved in water, provide free chlorine. All isocyanurated chlorine compounds (except sodium dichloroisocyanurate) when added to water tend to lower the pH by varying amounts. The use of isocyanurated chlorine is optional.

Research on outdoor pools has shown that chlorine residuals without isocyanuric acid had lost 90% of the chlorine residual on a sunny day in three hours. Pools containing 25 to 50 mg/L of isocyanuric acid under the same conditions lost only about 15% of the chlorine residual. No appreciable increase in chlorine stability occurred above 50 mg/L isocyanuric acid. An excess concentration of isocyanuric acid can be reduced only by dilution effects of rainfall or by topping up after filter backwashing. Once the desired level of isocyanuric acid has been reached in the pool (20 to 30 mg/L) the pool operator may cease using isocyanurated chlorine compounds and change to using other chlorine compounds. Isocyanurates must not be used under any circumstances in an indoor pool or indoor spa because of decreased rates of kill of some disease causing organisms and the increase in the delay of initiation of kill. Isocyanurates do not have any effect on bromine nor do excessive levels pose a health risk.

Ozone

Ozone is an unstable blue gas with a characteristic pungent odor, and a molecular formula of O_3. It is produced commercially from clean, cool, dry air or oxygen formed by the discharge of high voltage (4000 to 30000v) electricity. Ozone may also be produced as a "by product" by specific wavelength ultraviolet lamps. At air concentrations of 0.25 mg/L it is considered injurious to health. Its occupational threshold limit value is 0.1mg/L in air. At 1.0 mg/L in air it is extremely hazardous to health.

It is a short lived, unstable but powerful oxidizing and disinfection agent that does not react with porcelain or glass. Ozone disappears quickly from water. This is advantageous from the point of view that such a hazardous agent quickly disappears but disadvantageous from the point of view that no satisfactory disinfectant residual is provided in the pool itself. Ozone may not be used as the sole disinfectant in a public swimming pool or public spa pool but may be used in conjunction with chlorine or bromine. Where ozone is used with chlorine a reduction of free chlorine is permitted provided mainstream ozonation is practiced and the ozone is quenched using a bed of activated carbon preventing ozone from degassing in the swimming pool.

Where ozone is used in conjunction with bromine an activated carbon filter bed is not required provided that there is always an excess concentration of bromide in the water to ensure the complete destruction of residual ozone.

Polyhexamethylene Biguanide ("Baquacil" ®) And Hydrogen Peroxide

The disinfection system relies on the bacteriostatic properties of "Baquacil®" and a bi-weekly shock dose of hydrogen peroxide for oxidization. Its recommendation is largely limited as a pool disinfectant in domestic pool size disinfecting system (less than 25,000 gallons). "Baquacil®" is not well suited to handling shock loads but it does aid in the flocculation and removal of contaminants by filtration. It cannot be used in spa pools due to excess foaming.